VOLUME 144, 1993

JOURNAL OF CATALYSIS

EDITORS
Gary L. Haller, *Yale University*
Frank S. Stone, *University of Bath*

ASSOCIATE EDITOR
Robert S. Weber, *Yale University*

EDITORIAL BOARD

A. T. Bell
University of California Berkeley

J. S. Bradley
Exxon Res. & Eng. Comp.

R. L. Burwell, Jr.
Northwestern University

C. T. Campbell
University of Washington

M. Che
Université Pierre et Marie Curie

W. N. Delgass
Purdue University

P. Gallezot
IRC, Villeurbanne

W. O. Haag
Mobil Res. & Dev. Corp.

W. K. Hall
University of Pittsburgh

J. W. Hightower
Rice University

Y. Iwasawa
University of Tokyo

V. B. Kazansky
Zelinsky Inst. of Organic Chem.

H. Knözinger
University of Munich

J. H. Lunsford
Texas A&M University

J. E. Lyons
Sun Company

G. B. McVicker
Exxon Res. & Eng. Comp.

J. J. F. Scholten
Delft University of Technology

F. Solymosi
Attila József University

K. Tamaru
Science University of Tokyo

K. C. Taylor
General Motors Res. Labs.

Henrik Topsøe
Haldor Topsøe A/S

M. A. Vannice
Pennsylvania State University

R. A. van Santen
Eindhoven University of Technology

P. B. Wells
University of Hull

Founding Editors: J. H. de Boer and P. W. Selwood

ACADEMIC PRESS, INC.
Harcourt Brace & Company
San Diego New York Boston London Sydney Tokyo Toronto

Copyright © 1993 by Academic Press, Inc.

All Rights Reserved

No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopy, recording, or any information storage and retrieval system, without permission in writing from the copyright owner.

The appearance of the code at the bottom of the first page of an article in this journal indicates the copyright owner's consent that copies of the article may be made for personal or internal use, or for the personal or internal use of specific clients. This consent is given on the condition, however, that the copier pay the stated, per copy fee through the Copyright Clearance Center, Inc. (222 Rosewood Drive, Danvers, Massachusetts 01923), for copying beyond that permitted by Sections 107 or 108 of the U.S. Copyright Law. This consent does not extend to other kinds of copying, such as copying for general distribution, for creating new collective works, or for resale. Copy fees for pre-1993 articles are as shown on the article title pages; if no fee code appears on the title page, the copy fee is the same as for current articles.

0021-9517/93 $5.00

MADE IN THE UNITED STATES OF AMERICA

This journal is printed on acid-free paper.

Contents of Volume 144

Number 1, November 1993

Increased Catalytic Activity Caused by Local Destruction of Linear Zeolite Channels: Effect of Reduction Temperature on Heptane Conversion over Platinum Supported in H-Mordenite
Brian T. Carvill, Bruce A. Lerner, Bradley J. Adelman, Douglas C. Tomczak, and Wolfgang M. H. Sachtler 1

Oxidation of CO by NO over Rh(111)
David N. Belton and Steven J. Schmieg 9

Influence of Coke Deposition on Acidity, Intercrystalline Mass Transfer, and Catalytic Properties of Pt · H–ZSM-5 · Al_2O_3 Catalyst
Vasant R. Choudhary, S. Mayadevi, and Deepak B. Akolekar 16

Pt–Au/Al_2O_3 Catalysts: Preparation, Characterization, and Dehydrogenation Activity
D. Rouabah and J. Fraissard 30

CO_2-Reforming of Methane over Transition Metals
J. R. Rostrup-Nielsen and J-H. Bak Hansen 38

Peculiarities of Nickel Oxide Structure Transformation upon CO Hydrogenation. I. Initial Period of Catalyst Activation
O. S. Morozova, G. N. Kryukova, A. V. Ziborov, and L. M. Plyasova 50

Rapid Sintering in NO of Nanometre-Sized Pt Particles on γ-Al_2O_3 Observed by CO Temperature-Programmed Desorption and Transmission Electron Microscopy
P. Lööf, B. Stenbom, H. Nordén, and B. Kasemo 60

Processes in MoS_2 Gasification
X. Chu and L. D. Schmidt 77

Promotional Effect of Carbon Monoxide on the Decomposition of Ethylene over an Iron Catalyst
N. M. Rodriguez, M. S. Kim, and R. T. K. Baker 93

Effective Diffusivities in Zeolites. 3. Effects of Polarity, Cation Density, and Site Occupancy in ZSM-5
Sigfrido F. Garcia and Paul B. Weisz 109

Bimetallic Catalysts. V. Kinetics of the Hydrogenolysis of Butane over Pt–Mo/SiO_2 Catalysts
G. Leclercq, A. El Gharbi, and S. Pietrzyk 118

An *in-Situ* Infrared Study of the Formation of *n*- and iso-Butyraldehyde from Propylene Hydroformylation on Rh/SiO_2 and Sulfided Rh/SiO_2
Girish Srinivas and Steven S. C. Chuang 131

Catalytic Properties and Deactivation Behaviour of Crystalline Microporous MAPO-36
Deepak B. Akolekar 148

Selective Reduction of Diphenyldisulfides Catalysed by Sulfides—Influence of the Nature of the Catalyst
Christophe Calais, Michel Lacroix, Christophe Geantet, and Michèle Breysse 160

Low-Temperature Oxidation of CO over Gold Supported on TiO_2, α-Fe_2O_3, and Co_3O_4
Masatake Haruta, Susumu Tsubota, Tetsuhiko Kobayashi, Hiroyuki Kageyama, Michel J. Genet, and Bernard Delmon 175

Characterization of H,Na–Y Using Amine Desorption
A. I. Biaglow, D. J. Parrillo, and R. J. Gorte 193

The Effect of Loading of Vanadia on Silica in the Oxidation of Butane
L. Owens and H. H. Kung 202

Alcohol Decomposition by Reverse Spillover
Baoshu Chen and John L. Falconer 214

Temperature-Programmed Desorption Studies of the Interactions of H_2, CO, and CO_2 with Cu/SiO_2
Mark J. Sandoval and Alexis T. Bell 227

Isomerization of Alkanes on Sulfated Zirconia: Promotion by Pt and by Adamantyl Hydride Transfer Species
Enrique Iglesia, Stuart L. Soled, and George M. Kramer 238

Heterogeneities in Structure and Diffusion within Porous Catalyst Support Pellets Observed by NMR Imaging
Michael P. Hollewand and Lynn F. Gladden 254

$N + N \rightarrow N_2$ Reaction Rates on Rh(111)
David N. Belton, Craig L. DiMaggio, and K. Y. Simon Ng 273

Studies of Acidic Sites on Boralites by Temperature-Programmed Desorption (TPD) of NH_3, C_2H_4, and 1-C_4H_8
Wen-Qing Xu, Steven L. Suib, and Chi-Lin O'Young 285

Effects of High-Temperature Aging on the Dispersion of Rh/Al_2O_3
Donald D. Beck and Constance J. Carr 296

XAFS Characterization of Rh/Al_2O_3 after Treatment in High-Temperature Oxidizing Environments
D. D. Beck, T. W. Capehart, C. Wong, and D. N. Belton 311

Catalytic Deuterium Exchange and Hydrogenolysis Reactions of 1,2-Dimethylhydrazine on Transition Metals
S. R. Logan 325

Oxidative Coupling of CH_4 on Ag Catalyst-Electrodes Deposited on ZrO_2 (8 mol% Y_2O_3)
P. Tsiakaras and C. G. Vayenas 333

Notes

Catalytic Activity of $H_3PMo_{12}O_{40}$-Blended Polysulfone Film in the Oxidation of Ethanol to Acetaldehyde
In Kyu Song, Sung Kil Shin, and Wha Young Lee 348

The Role of Lattice Oxygen during the Oxidative Coupling of Methane over Li^+-Doped TiO_2 Catalysts
A. M. Efstathiou, D. Papageorgiou, and X. E. Verykios 352

Letters to the Editors

Comments on Sudhakar Rao *et al.* on "An Experimental Study of Cyclic Operation of a Benzene Hydrogenation Reactor"
P. L. Silveston and R. R. Hudgins 358

Reply to Comments by P. L. Silveston and R. R. Hudgins
K. B. S. Prasad 360

Number 2, December 1993

The Effect of Hydrogen Coadsorption on the Thermal Chemistry of Methyl Iodide on Ni(100) Surfaces
Sariwan Tjandra and Francisco Zaera 361

The Varying Effects of N_2, H_2, CO_2, and CO as Diluents in 2-Methylpentane Cracking on HY
Yingxian Zhao and B. W. Wojciechowski 377

Preparation of Pt/Alumina Catalysts by the Sol–Gel Method
Krishnan Balakrishnan and Richard D. Gonzalez 395

A Comparative Study of Methanol Synthesis from CO_2/H_2 and CO/H_2 over a $Cu/ZnO/Al_2O_3$ Catalyst
Jae Sung Lee, Kee Hyouk Lee, Sang Young Lee, and Young Gul Kim 414

Influence of the Preparation Methods of V–Mg–O Catalysts on Their Catalytic Properties for the Oxidative Dehydrogenation of Propane
A. Corma, J. M. López Nieto, and N. Paredes 425

Temperature-Programmed Reduction and CO Hydrogenation of La_2O_3-Promoted Rh/SiO_2 Catalysts
A. L. Borer and R. Prins 439

Active Sites and Redox Properties of Supported Palladium Catalysts for Nitric Oxide Direct Decomposition
Atsushi Ogata, Akira Obuchi, Koichi Mizuno, Akihiko Ohi, and Hideo Ohuchi 452

Properties of Supported Pd–Ni Catalysts Prepared by Coexchange and by Organometallic Chemistry. I. Preparation and Characterization by X-Ray Diffraction, Analytical Microscopy, and EXAFS
J. F. Faudon, F. Senocq, G. Bergeret, B. Moraweck, G. Clugnet, C. Nicot, and A. Renouprez 460

The Effect of the Calcination Temperature on the Activity of Re_2O_7/γ-Al_2O_3 Catalysts for the Metathesis of Propene
R. Spronk, J. A. R. van Veen, and J. C. Mol 472

Effects of Support Material and Sulfation on Propane Oxidation Activity over Platinum
C. P. Hubbard, K. Otto, H. S. Gandhi, and K. Y. S. Ng 484

Hexane Cracking in ZSM-5: *In Situ* ^{13}C Cross-Polarization Magic-Angle-Spinning NMR and Flow Reactor/GC Experiments
A. K. Nowak, A. E. Wilson, K. Roberts, and K. P. Datema 495

Oxidation of Reduced Platinum Clusters in Pt–NaY
B. F. Chmelka, G. T. Went, R. Csencsits, A. T. Bell, E. E. Petersen, and C. J. Radke 506

CO-Induced Morphological Changes of Rh Crystallites: Mechanisms, Kinetics, and Real-Space Imaging on the Atomic Scale
N. Kruse and A. Gaussmann 525

Hydrogen Species, Vacancies, and Alkadiene Hydrogenation Selectivity on Copper-Based Hydrogen Reservoirs
A. Sene, L. Jalowiecki-Duhamel, G. Wrobel, and J. P. Bonnelle 544

Reactions of Aliphatic α-ω-Diamines in H^+-Pentasils
Walter T. Reichle 556

Enantioselective Hydrogenation of Ethyl Pyruvate: Kinetic Modeling of the Modification of Pt Catalysts by Cinchona Alkaloids
H. U. Blaser, M. Garland, and H. P. Jallet 569

The Effect of Passivation on the Activity and Structure of Sulfided Hydrotreating Catalysts
S. P. A. Louwers, M. W. J. Crajé, A. M. van der Kraan, C. Geantet, and R. Prins 579

Phase Equilibria and Butane Oxidation Studies of the $MgO–V_2O_5–MoO_3$ System
W. D. Harding, H. H. Kung, V. L. Kozhevnikov, and K. R. Poeppelmeier 597

Influence of Hydrogen Pretreatment on the Structure of the Metal-Support Interface in Pt/Zeolite Catalysts
M. Vaarkamp, F. S. Modica, J. T. Miller, and D. C. Koningsberger 611

Notes

Bi–K–Graphite Intercalation Compound as a New Catalyst for Styrene Synthesis
Roman Klimkiewicz, Antoni W. Morawski, and Włodzimierz Mišta 627

Effects of Methods of Preparing Iron Phosphate and P/Fe Compositions on the Catalytic Performance in Oxidative Dehydrogenation of Isobutyric Acid
M. Ai, E. Muneyama, A. Kunishige, and K. Ohdan 632

A Study of the CO_2 Chemisorption on Supported Molybdena–Alumina Catalysts
L. Gonzalez, J. L. Galavís, C. Scott, M. J. Pérez Zurita, and J. Goldwasser 636

Author Index for Volume 144 641

Cumulative Author Index for Volumes 139–144 643

Cumulative Subject Index for Volumes 139–144 650

INFORMATION FOR AUTHORS

The *Journal of Catalysis* publishes articles dealing with original studies in heterogeneous and homogeneous catalysis as well as studies relating catalytic properties with chemical processes at surfaces, studies of chemistry of surfaces, and engineering studies related to catalysis. All articles will be published in English.

Submission of Manuscripts. Manuscripts should be sent by registered mail to either of the Editors:

Professor Gary L. Haller
Department of Chemical Engineering
P.O. Box 2159 Yale Station
Yale University
New Haven, Connecticut 06520

Professor Frank S. Stone
School of Chemistry
University of Bath
Bath BA2 7AY, England

Original papers only will be considered. Manuscripts are accepted for review with the understanding that the same work has not been published, that it is not under consideration for publication elsewhere, and that its submission for publication has been approved by all of the authors and by the institution where the work was carried out; further, that any person cited as a source of personal communications has approved such citation. Written authorization may be required at the Editor's discretion. Articles and any other material published in the *Journal of Catalysis* represent the opinions of the author(s) and should not be construed to reflect the opinions of the Editor(s) and the Publisher.

Authors submitting a manuscript do so on the understanding that if it is accepted for publication, copyright in the article, including the right to reproduce the article in all forms and media, shall be assigned exclusively to the Publisher. The Publisher will not refuse any reasonable request by the author for permission to reproduce any of his or her contributions to the journal.

Form of Manuscript. Manuscripts should be concise and consistent in style, spelling, and use of abbreviations. Submit manuscript (in English) in triplicate, including the original typewritten copy, with copies of all figures and tables. Originals of micrographs should also be submitted in triplicate for purposes of manuscript reviewing. All material (including tables, reference lists, etc.) should be typed double-spaced on one side of 8.5 × 11-in. white bond paper (with 1-in. margins on all sides). Each page of the manuscript should be numbered. *Page 1* should contain the article title, authors' names (without degrees), affiliations, a running title (abbreviated form of title) not exceeding 45 letters and spaces, and the name and complete mailing address (and telephone and fax numbers, if possible) of the person to whom proof should be mailed. *Page 2* should contain a short abstract.

Authors should use descriptive headings in this order: Abstract, Introduction, Methods, Results, Discussion, Acknowledgments, and References.

In the Methods section, authors should draw attention to any particular chemical or biological hazards that may be involved in carrying out the experiments described. Any relevant safety precautions should be described; if an accepted code of practice has been followed, a reference to the relevant standards should be given.

If the manuscript refers to recently submitted manuscripts or papers in press (with the *Journal of Catalysis* or other journals) then please supply three copies of them so that the reviewers can judge the new manuscript in its proper context.

Revised manuscripts should be returned with one copy marked to show where changes have been made.

Notes and *Letters to the Editor* may not exceed 8 double-spaced typewritten manuscript pages (including tables and figures). Accepted Notes will not receive publication priority over articles.

Letters to the Editor will be considered for priority publication under the following conditions: (a) Letters must be related to some statement made in a recently published article in this Journal; (b) in cases of conflicting views on any topic, no more than one Letter from each author will be accepted.

Units of weights, measures, etc., when used in conjunction with numerals should be abbreviated and unpunctuated (e.g., 10%, 50 ml, 3 g, 8 cm).

The SI (Systeme International) system of units will be accepted without editorial change. Authors using other units are encouraged to define them in terms of SI units once in each publication, e.g., in an article where pressures are quoted in Torr to write "1 Torr = 133.3 N m^{-2}." For information concerning SI units, see *Quantities, Units and Symbols for Physical Chemistry*, 4th ed., prepared by I. Mills and published by Blackwell Scientific, Oxford, 1988.

Footnotes should be avoided if possible; but if essential, they should be designated by superscript Arabic numerals (starting with title) in the text.

Tables should be numbered with Arabic numerals in order of mention in the text. They should be typed double-spaced on separate pages. Each table should have a short descriptive caption typed (double-spaced) above the table. Table footnotes (indicated by superscript, lowercase, italic letters) should be typed at the end of the table.

Figures should be numbered with Arabic numerals in order of mention in the text; each figure should have a descriptive legend. Legends should be typed double-spaced together on a separate page. All illustrations should be in finished form suitable for reproduction. They should be planned to fit the proportion of the printed page (5.5 × 8 in.; column width, 2-5/8 in.). No figures should exceed 8.5 × 11 in. (21 × 27.5 cm). Lettering on drawings should be of professional quality or generated by *high-resolution* computer graphics and should be large enough (10–12 points) to take a reduction of 50–60%. Drawings should be made with black India ink on tracing linen, smooth-surface white paper, or Bristol board. Alternatively, *high-quality* computer graphics may be acceptable. Graph paper if used should be ruled in blue. Grid lines that are to show in the final reproduction should be inked in black.

Copies of drawings are not acceptable unless they are high contrast glossy prints. All but the very simplest structures and structural formulas must be designed for direct reproduction. Illustrations in color can be accepted only if the authors defray the cost.

Electron micrographs. Please supply three photographic copies of these so that the reviewers can inspect the fine details they contain.

References to the literature should be cited in the text by italic Arabic numerals in parentheses, set on the text line, and listed numerically at the end of the paper. Abbreviations of journal titles should follow the style used in *Chemical Abstracts' Service Source Index*, 1985. Style and punctuation of references should be in accordance with the following examples:

1. Latef, A., Aissi, C. F., and Guelton, M., *J. Catal.* **119,** 368 (1989).

2. Louis, C., and Che, M., *in* "Reactivity of Solids" (P. Barret and L. C. Dufour, Eds.), Vol. B, p. 1057. Elsevier, Amsterdam, 1985.

3. Pines, H., "The Chemistry of Catalytic Hydrocarbon Conversions." Academic Press, New York, 1981.

Proofs. Proofs will be sent to the author, with a reprint order form. Authors will be charged for alterations in excess of 10% of the cost of composition.

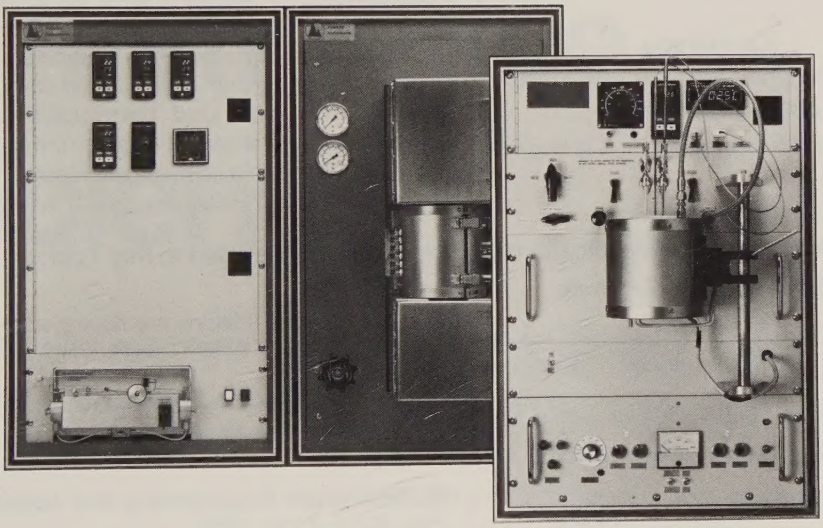
Reprints. Fifty reprints without covers will be provided free of charge. Additional reprints may be purchased; an order form will be included with proofs.

Personal Computer Disks. Manuscripts may be submitted to the *Journal of Catalysis* on personal computer disks after the manuscript has been accepted and after all revisions have been incorporated onto the disk. Please supply the file as a straight ASCII file with generic codes specified by the publisher. Label the disk with the type of computer used, the type of software and the version number, and the disk format. All tabular and mathematical material will be typeset conventionally. Art must be prepared as camera-ready copy; see the section on Figures earlier in this Information for Authors.

A hard copy printout of the manuscript that exactly matches the disk file must be supplied. Academic Press will not accept disks without accompanying printouts of all files on the disk. File names must clearly indicate the content of each file. The manuscript will be edited according to the style of the journal, and the proofs must be read carefully by the author. Disks that are not translatable or economical to process will not be used. The publisher reserves the right not to use the disk.

For further information on preparing the disk for typesetting conversion and a list of generic codes, please contact the publisher (Editorial Supervisor, Journal Division, Academic Press, 525 B Street, Suite 1900, San Diego, California 92101–4495; telephone: (619) 699-6415; fax: (619) 699-6800).

If you find catalyst research too slow, too labor-intensive or too limited...



We offer two solutions

Altamira's *Catalyst Characterization Systems* are designed for researchers with too little time and too few people. The AMI-1 performs TPD, TPR, TPO, TP reaction, chemisorption, BET and pore size distribution. You can set up an experiment in as little as 30 minutes, then walk away and the AMI-1 will do the work for you.

For increased thruput, the new AMI-3 lets you load 3 samples for simultaneous operation.

Altamira also offers AMI-2000 *Bench-Scale Reactor Systems* which are customized to your specifications. Tell us about your application and hardware requirements. Altamira will do the rest. We'll deliver a turnkey system and train your personnel onsite. Manual and automated systems are available.

To obtain the name of the sales representative in your area, contact: Altamira Instruments, 2090 William Pitt Way, Pittsburgh, PA 15238 USA • Tel: (412) 826-3080 • FAX: (412) 826-3081 • Telex: 5106019265.

Altamira Instruments

Journal of Parallel and Distributed Computing

Allan Gottlieb
Editor, Hardware and Software Systems
New York University, New York City

Kai Hwang
Editor-in-Chief for Special Issues and Invited Papers
University of Southern California, Los Angeles

Sartaj Sahni
Editor, Algorithms and Applications
University of Florida, Gainesville

This international journal is directed to researchers, engineers, educators, managers, programmers, and users of computers who have particular interests in parallel processing and/or distributed computing. The **Journal of Parallel and Distributed Computing** publishes original research papers and timely review articles on the theory, design, evaluation, and use of parallel and/or distributed computing systems.

Special Issues Devoted to Key Topics in the Field

These informative editions are now available for purchase as single issues. Each Issue: $35.00

- **Scheduling and Load Balancing**
  (Vol. 16, No. 4, Dec. 1992)
- **Multicomputer Programming and Applications**
  (Vol. 16, No. 2, Oct. 1992)
- **Memory System Architectures for Scalable Multiprocessors**
  (Vol. 15, No. 4, Aug. 1992)
- **Petri Net Modeling of Parallel Computers**
  (Vol. 15, No. 3, July 1992)
- **Intelligence Processing Computer Systems**
  (Vol. 15, No. 2, June 1992)
- **Neural Computing on Massively Parallel Processors**
  (Vol. 14, No. 3, Mar. 1992)

Volumes 17–19 (1993), 12 issues
ISSN 0743-7315

	In the U.S.A. and Canada	All other countries
Institutional rate:	$324.00	$407.00
Personal rate:	94.00	132.00

Personal rates are available only on orders placed directly with the Publisher and paid for with personal funds. For more information, please write or call:

ACADEMIC PRESS, INC.
Journal Promotion Department
1250 Sixth Avenue
San Diego, CA 92101, U.S.A.
(619) 699-6742

All prices are in U.S. dollars and are subject to change without notice. Canadian customers: Please add 7% Goods and Services Tax to your order.

Under New Editorial Direction

Journal of Colloid and Interface Science

Editor-in Chief
Darsh T. Wasan
Illinois Institute of Technology, Chicago

Publishing original research on fundamental principles and their applications, the **Journal of Colloid and Interface Science** is concerned with the work of investigators in relevant areas of chemistry, physics, engineering, biology, and applied mathematics. The journal features original research contributions from university, government, and industrial laboratories world-wide; book reviews; and letters to the editors.

Volumes 155–161 (1993), 14 issues
ISSN 0021-9797
In the U.S.A. and Canada: $1145.00
All other countries: $1335.00

Sample copies and privileged personal rates are available upon request.
For more information, please write or call:
ACADEMIC PRESS, INC., Journal Promotion Department
1250 Sixth Avenue, San Diego, CA 92101, U.S.A. (619) 699-6742

All prices are in U.S. dollars and are subject to change without notice. Canadian customers: Please add 7% Goods and Services Tax to your order.

S3132

Today's Advances are Tomorrow's Technology.
Get the Facts.

ENCYCLOPEDIA OF PHYSICAL SCIENCE AND TECHNOLOGY

SECOND EDITION

edited by
Robert A. Meyers

From the Reviews of the First Edition

"Comprehensive, current, easy to use, and authoritative.... It exceeds all of its goals of providing a scholarly encyclopedia covering the physical sciences, mathematics, and engineering. It is highly recommended for large public libraries with a science and technology division, academic libraries, and special libraries with an interest in science and engineering."

—BOOKLIST/REFERENCE BOOKS BULLETIN

"The outstanding feature of this work is the currency of the material covered. This reference tool will serve as a research aid for scholars and advanced students and will find use in academic, special and large and medium-sized public libraries."

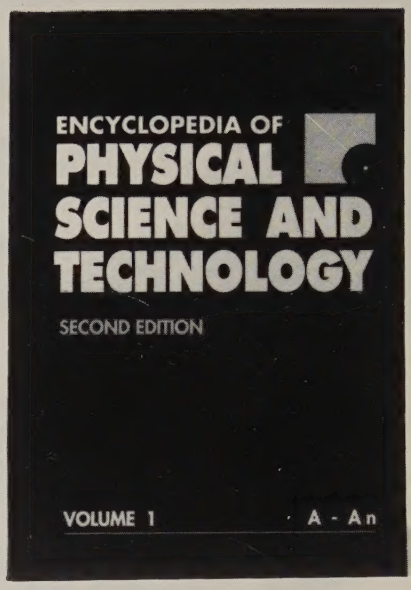
—THE NEW YORK PUBLIC LIBRARY

"I expect it to become a standard in every library attempting to represent broadly the fields of science and technology."

—THE LOS ANGELES PUBLIC LIBRARY

"This encyclopedia will be a very useful and needed addition to the literature of the physical sciences and technology."

—AMERICAN REFERENCE BOOKS ANNUAL



A massive revision of the distinctive **Encyclopedia of Physical Science and Technology**, this **Second Edition** includes 155 new articles that fill three volumes—a total of 2,400 additional pages. This eighteen-volume work maintains the high quality of the original edition, praised by both the Los Angeles and New York Public Libraries. Featuring longer and more complete articles than other similar works and specifically covering all the physical sciences, this encyclopedia deserves a place on every library's bookshelf.

Comparison of the First and Second Editions	*First Edition*	*Second Edition*
Volumes	15	18
Articles	550	705
Pages	11,651	14,080
Bibliographic Entries	5,000	6,500
Figures	6,600	8,500
Tables	1,400	1,800
Illustrations	5,500	8,200
Glossary Entries	6,800	8,700
Index Entries	55,000	70,000
Chemical and Mathematical Equations and Algorithms	13,850	17,625

Key Features

- Articles are arranged alphabetically for easy access
- Each entry begins with a detailed table of contents, a glossary of unusual terms, and a concise definition of the topic, followed by an in-depth presentation
- Extensive cross-references
- Each article has passed a review by its author's peer group
- 92% of the articles have been revised and updated
- 155 articles have been added

Eighteen-Volume Set
1992, 14,080 pp., $2500.00/ISBN: 0-12-226930-6

ACADEMIC PRESS
Harcourt Brace Jovanovich, Publishers
HBJ Order Fulfillment Dept. #42013
6277 Sea Harbor Drive, Orlando, FL 32887

Prices subject to change without notice. © 1993 by Academic Press, Inc.
All Rights Reserved. LK/CEP/SW—42013.